Block Copolymer Nanoarchitectures for Radio Frequency Applications
Final Report 01/2006

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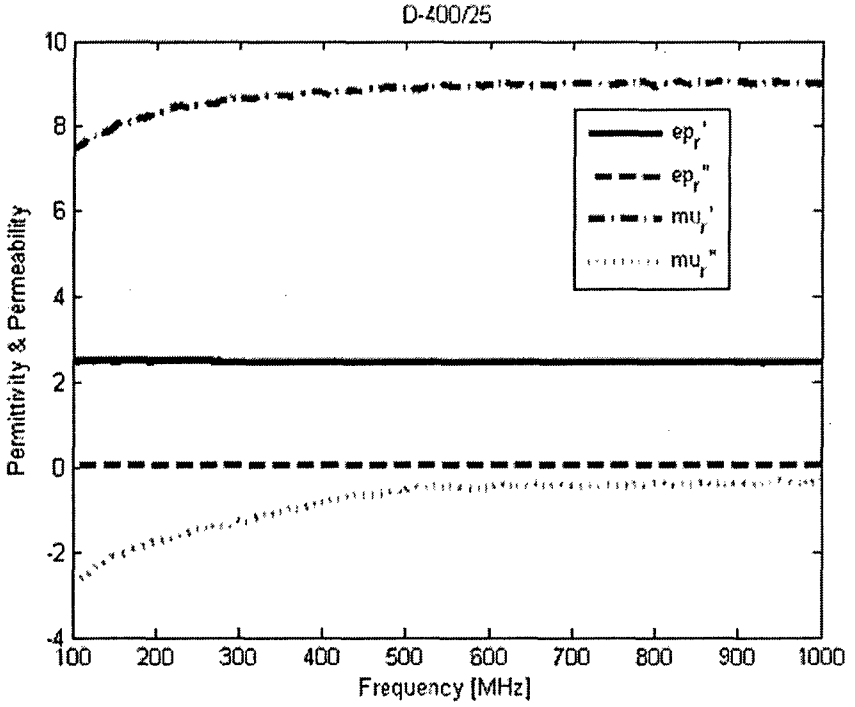
Objectives: The goal of this research is to develop flexible polymeric nanocomposites having high permitivities and permeabilities for use in radio frequency (RF) applications.

Status of Effort: We synthesized nanocomposites based on the self-assembly of block copolymers templated with mixed metal oxides of high dielectric constant and high magnetic susceptibility. Low frequency magnetic and dielectric measurements as well as microstructural characterization were carried out at U of Maryland, while high frequency measurements were performed by Leo Kempel AFRL, sensors directorate.

Accomplishments / New Findings: Experimental results with mixed oxides of Iron and Strontium templated within norbornene-norbornene dicarboxylic acid block copolymers have produced nanocomposites with low loss at high frequencies and a ratio of $\int$ to Σ of 4 (Figure 1). The impact of this research relates to the development of nanocomposites for flexible antennas with improved properties: For example, compared to a standard alumina antenna, for a given antenna dimension the operational frequency can be reduced by 36% (from 2.4 GHz to 875 MHz) using the synthesized polymer nanocomposite, and for a given frequency (875 MHz), the polymer antenna has 41% smaller dimensions (5.64x4.24 cm alumina vs 4x3 cm polymer) than the alumina antenna, and more importantly has 2 orders of magnitude increase in usable bandwidth (0.03 % alumina versus 3.4% polymer). The ease of processing a polymer allows the production of thin film nanoscale self-assembled RF nanocomposites that could be wound into coils or processed as coatings and sheets.

Figure 1: High frequency permittivity and permeability measurements of block copolymer nanocomposite



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14. ABSTRACT

The goal of this research is to develop flexible polymeric nanocomposites having high permitivities and permeabilities for use in radio frequency (RF) applications. The nanocomposites are based on the self-assembly of block copolymers. A variety of mixed metal oxides of high dielectric constant and high magnetic susceptibility are templated within different block copolymer structures. Experiments with mixed oxides of Iron and Strontium have produced nanocomposites with low loss at high frequencies and a ratio of μ to ε of 4. The ease of processing a polymer would allow the production of thin film nanoscale self-assembled RF nanocomposites that could be wound into coils or processed as coatings and sheets.

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Undergraduate Students: Joshua Silverstein

Publications:

"An investigation of the templating of Fe_2O_3 nanoparticles within carboxylic acid functionalized Diblock Copolymers" P. Akcora, R.M. Briber, and P. Kofinas. Polymer, under review.

Interactions/Transitions: Presentation acknowledging AFOSR support was given at the American Chemical Society Fall meeting in Washington, DC, August 2005.

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Honors/Awards: None